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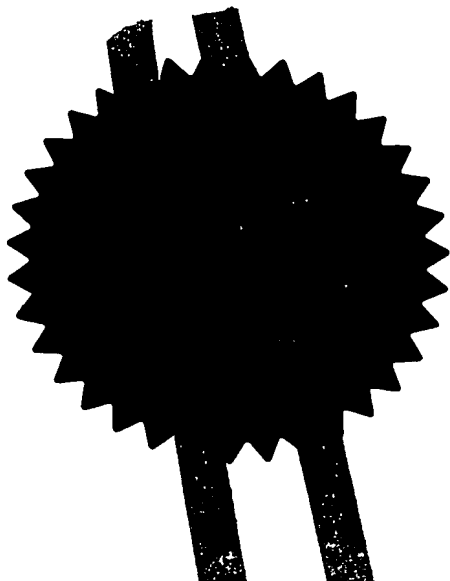
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2. Patent application number (The Patent Office will fill in this part)	0313808.8		16 JUN 03 FR15119-2 D02866 P01/7700 0.00-0313808.8 14 JUN 2003
3. Full name, address and postcode of <u>each</u> of <u>the</u> <u>applicant</u> (underline all surnames)	Ronald Peter <u>BINSTEAD</u> Binstead Designs Ltd 15 Seely Road Nottingham NG7 1NU United Kingdom  Patents ADP number (if you know it) 8652703001  If the applicant is a corporate body, give the country/state of its incorporation		
4. Title of the invention	IMPROVEMENTS IN TOUCH TECHNOLOGY		
5. Name of your agent (if you have one)	ERIC POTTER CLARKSON		
"Address for service" in the United Kingdom to which all correspondence should be sent (including the postcode)	PARK VIEW HOUSE 58 THE ROPEWALK NOTTINGHAM NG1 5DD		
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Patent application by:  
R.P.Binstead  
15 Seely Road, Nottingham NG7 1NU, England  
10th June 2003

### Improvements in touch technology

The present invention relates to surfaces that detect the exact position of a finger or similar object, touching, or coming very close to that surface, by an array of proximity sensing conductors.

A known touch technology of this type is described in US Patent number 6,137,427.

Isolated horizontal and vertical rows of sensor conductors detect the proximity of a finger by a capacitance effect. By use of interpolation, it is possible to detect the position of a finger between conductors.

Difficulty occurs if the conductors are widely spaced apart. When touching between conductors, very small data values are available for interpolation.

This leads to errors in calculating the exact position of the finger.

Another problem occurs when the palm of the hand is held just above the sensing surface. This produces a strong signal, which could be determined falsely to be a touch.

In the current invention techniques are used to alter the capacitance of the system in a way that overcomes these problems.

This is done either, by providing a medium with high levels of capacitive coupling, or, by providing an electricly conductive medium close to the sensing conductors, or by a mixture of both of these.

The devices, covered by this invention, are not electricly connected to the sensing conductors and may be sited on top, underneath, on top and underneath, or completely encapsulating, but insulated from, the sensing conductors.

If a resistive device is used, the resistivity of this material should ideally be within the range of 100 ohms per square to 10,000,000 ohms per square.

A purely capacitive device will have a restivity of many millions of ohms.

When a finger touches, or comes very close to this medium, it immediately induces a large change in capacitance detectable by the sensing conductors. It also radially spreads the capacitive signal away from the touch point with a strength that diminishes as distance increases from that point. With the resistive medium, the rate of signal attenuation is related to the resistance of the medium.

Very conductive media spread the signal over a wide area whereas slightly conductive media spread the signal over a very small area.

Above 10,000,000 ohms per square, the effect is almost undetectable. Conductivity of 1000,000,000 ohms per square or more, is still useful, however, as an anti-static device. If the conductive medium is uniform, the signal will spread out evenly in all directions

from the point of touch.

Variations in resistance of the conductive medium do, however, have an effect on linearity. Small variations, however, are hardly noticeable, because the operational resistance range is so large. It may be useful, however, to have some areas with much greater conductivity than others, to have some control of how the signal is spread. The conductivity may be varied by the chemical mix of the medium, variations in thickness, or both of these.

A medium with no conductivity, low conductivity, medium conductivity, and high conductivity, or continuously variable conductivity, may all be used together. In this way, it is possible to control the effect of touch on the sensing system.

The medium may be formed into complex 2 and 3 dimensional shapes, by many different means, including vacuum forming and injection moulding. Its surface may be flat, or curved, with grooves, dimples, hollows etc..

The medium may be the only support for the sensing conductors, or it may be one of two or more media, some of which conduct and some which do not conduct. For example, layers of glass or other non-conducting materials (dielectrics) may be used to make up the touch surface, the conducting material being between the glass and the user, underneath the glass, both sides of the glass, or between layers of glass.

The conductive material may be the top surface, and touched directly by the operator. It is still proximity sensing and so will still work if the operator is wearing thin gloves.

A thin, non-conducting layer may be used to coat the surface, preventing direct touch of the conductive material. This may be required to protect the conductive layer from damage, to provide an anti-reflective finish, and/ or to provide a decorative finish. In the case of the product being used as a keypad, this coating may be printed with icons, indicating which position corresponds to key positions.

The conductive medium may be left electricly floating, with no electrical connection to the sensing conductors or the control circuit. It may be connected to ground or earth, either directly or through a resistor, thus doubling as an anti-static and emi shielding surface. Alternatively, it may be connected to a sensing circuit which is used to indicate the exact time the medium is touched. This circuit may induce a voltage, or varying voltage on the conductive medium. This system would allow much faster sensing than the process used in the original patent - detecting the exact time of touch in a few micro-seconds as opposed to a few milliseconds. The original detection circuit would still be used to detect the exact position of touch and possibly confirm that a touch has occurred.

The sensing circuit could be sent to sleep, waking periodically to measure the background conditions. The present invention would detect any touch, and wake up the sensing circuit. This would then scan the surface to determine the touch position. The advantage of this is that touch is detected in a very short time, but the circuit consumes very little power. Average power requirements for this circuit could be just a few micro-amps. The circuit could then very easily be solar powered, or run off a small battery for many years.

The use of this circuit would still allow the conductive medium to act as an anti-static and emi-shielding surface.

The medium may be clear, translucent or opaque, depending on the application. Its conductivity may be due to a conductive surface coating or bulk conductivity, with the plastic, or glass itself being conductive. It may also have a mixture of both of these.

#### Touchscreens.

If used as a touchscreen, the material is normally clear.

The usual materials used are glass, or plastic, coated with Indium Tin Oxide (ITO) or Antimony Tin Oxide (ATO).

Plastic or glass completely coated on either or both surfaces, with these oxides, may be used directly if the resistivity is within the required range.

Normally, however, this material is manufactured with a resistivity of 10 ohms per square or less which is too low for this invention to work. When the finger touches one part of the material, the effect is spread too wide across the surface to pinpoint the exact position of touch.

To overcome this problem, the coating may be partially etched away or deposited as an incomplete layer by use of masks.

The ITO, or ATO, may be broken up into isolated "islands" of conductive material surrounded by non-conducting glass or plastic. If used as a keypad, these islands may be at the site of a corresponding key. Their size and shape may, in fact, be the key's shape and size.

If the surface is to be used as a co-ordinate position indicator, the ITO may be broken up into many, very small isolated islands evenly spread all over the surface with very thin non-conducting zones between them.

When touched, the capacitive signal will spread slightly from the touched "island" to the near neighbours, creating the required conditions for this invention to work.

This effect will be improved by having a similarly etched coating on both sides of the glass but with some overlap of the parallel conductive islands to increase capacitive coupling around the point of touch.

The resistance of the surface will be very large, in this situation, in the order of thousands of millions of ohms per square, but the invention will still work due to capacitive spread through the glass dielectric.

Alternatively, the resistance of the ITO may be increased from about 10 ohms per square to the required range of values by evenly etching away much of the coating, leaving a thinner, more resistive layer, or completely etching away parts of the layer leaving many small, highly conductive "islands" of ITO surrounded by non-conductive glass or plastic but linked together by thin bridges of ITO, or a mixture of both these techniques.

Another alternative is to use a plastic, or glass, with bulk conductivity.

Normally clear conductive plastics have a very high resistance in the range of 1,000,000,000 ohms per square, but this may be reduced by adding small quantities of conductive particles or fibres to the plastic. These particles are not necessarily transparent, but are small enough, not to be visible. These particles may be metals, metal oxides or other conductors such as carbon fibres or nanotubes. They may be up to a few microns wide, and in the case of fibres, may be up to a few millimetres long.

The particles are linked together by the conducting plastic matrix forming a transparent conductive sheet within the required resistance range.

For "back-projected" touchscreens, the screen material is not clear but translucent, enabling more conductive particles to be added to the plastic.

Keypads, mobile phones and interactive work-surfaces.

For these applications, the conductive material may be opaque, thus opening up the use of many more conductive materials which may have surface conductivity and/ or bulk conductivity.

For a medium with surface conductivity only, such as printed circuit board material, copper could be etched away leaving many small isolated islands of conductive copper separated from each other by a thin non-conductive zone, and other techniques, similar to those mentioned above for transparent materials. The dielectric properties of pcb material, however, are not very well suited to the technique mentioned above which uses capacitive spread throughout the body of the supporting medium alone to make this invention work.

Non-conductive plastics can be made conductive in many different ways. They may be electro-plated, sputter coated, or painted, sprayed, screen printed, ink-jet printed, with conductive ink, etc..

There are, also, many conductive plastics which have bulk conductivity.

Many conductive plastics, for anti-static applications, have resistances in a range suitable for this application, especially those with embedded graphite.

Graphite, or other conductive substances, can be embedded in many different types of plastic, which can then be laminated, vacuum formed and injection moulded.

Thus it is possible with this invention to produce many different two and three dimensional touch interactive materials and products.

For example, this invention could be used to produce mobile phones with the injection moulded case itself being touch interactive, so there is no need for a separate keypad and/or touchscreen to be added.

Touch sensitive and non touch sensitive areas can exist in the same injection moulding by zoning the sensing conductors and having conducting and non-conducting, clear and opaque plastics in the one injection moulding.

By this method, the front, the back, the sides, top bottom, all edges and corners could be touch interactive. Surfaces may be touchscreens, keypads, digitizing tablets, trackballs or change function from one to the other when and as required.

The conductive layer does not have to be a solid but could be a fabric, rubber, foam, liquid (e.g. sea water), a gel or even a conductive gas, such as a plasma. Some of these may, however, require a conductive or non-conductive outer membrane to keep them in place and protect them.

Conductive media that distort, or change resistance, when touched have the added advantage that the capacitive signal detected increases much more strongly than non-distorting media, when pressure is applied, allowing extra powerful z-axis resolution.

Conductive earthed/grounded or active backplanes may be incorporated into the system at various levels. An insulated layer may be needed to prevent these short-circuiting to

the conductive medium.

A solid state touch-interactive sheet that can be touched independently on both sides at once could be made using this technology with a ground or active backplane in the middle.

A number of independent touch systems could also exist on one surface. If very close together, earthed or grounded planes may be incorporated between them to prevent interference between one system and the next.

This system could be used to create a totally flat shop counter with many epos machines built into the one surface.

If a suitable plastic is used, the medium may be used as the resonant surface of a speaker. This may be temporarily interfered with if being touched, i.e. if being used as a touchscreen or keypad at the same time as it is being required to make sounds, but will resume proper speaker functionality when the finger is removed. A suitable speaker driver technology would be a NXT system.

The addition of a thin, flexible display technology as one of the layers in the system, allows the production of a complete touch-interactive, flexible display system. Technologies such as e-ink, oled (organic light emitting displays) and leps (light emitting polymers) would be suitable.

## Diagrams.

Fig1. shows a stylised layout of a touch sensor system as described in US patent 6,137,427. A cross section, A-B, is indicated as a reference cross section in the following diagrams.

Fig2. shows section A-B in side view. This shows two insulation coated sensor wires (2) encapsulated in a non-conducting, dielectric medium (3).

This section will be referred to as the sensing layer.

A finger (1) touching the surface of the dielectric, half way between the sensing wires, is weakly detected by those wires.

Fig3. shows a conductive layer (4), as described in this patent, mounted on top of the dielectric layer in Fig2.. This also shows that the operators finger directly touches the conductive layer. The conductive layer spreads the signal out evenly from the touch point, creating a strong signal that is readily detected by the sensing wires. At the actual time of contact a massive increase in signal is produced.

Fig4. shows the conductive layer underneath the dielectric layer. This time the finger touches the dielectric layer. The conductive layer spreads the signal out, as in Fig3., but, since the conductor is not directly touched, there is not such a strong signal change at the moment of touch.

Fig5. shows that the dielectric layer completely replaced by the conductive medium. The sensing wires do not short circuit to this, however, due to the insulation coating on the wires. This situation produces a very strong signal when touched.



Fig6. shows the same set-up as Fig3. but with a thin non-conducting layer (5) on top of the conducting layer. The finger touches the top non-conducting layer and is sensed through this. The touch signal is spread out by the conductive layer, but the impact of touching the top non-conductive layer is slightly weaker than occurs in the Fig3. arrangement.

Fig7. shows the sensing layer, as described in Fig2., with a thick layer of glass (6), or other dielectric, on top, and the conducting layer on top of that. The finger touches the top, conducting layer and is sensed through the glass by the bottom sensing layer. The conducting layer produces a much stronger signal, when touched, than occurs when the conducting layer is not present.

Fig8. shows the same arrangement as Fig7. but with a thin non-conducting layer on top of the conducting layer. The finger touches the top, non-conducting layer, and is sensed through this, the conducting layer and the glass, by the sensing layer.

Fig9. shows the conducting layer underneath the glass but on top of the sensing layer. The finger touches the top of the glass, is sensed through the glass and the conducting layer by the bottom sensing layer. The conducting layer spreads out the signal, producing a much stronger response by the detecting wires than occurs if it is not present.

Fig10. shows the conducting layer underneath the sensing layer, which, in turn, is underneath the glass. When the finger touches the top of the glass, it is sensed through the glass by the sensing layer. The conducting layer spreads out the signal, producing a stronger response by the detecting wires than occurs if it is not present.

Fig11. shows a conducting layer on both sides of the glass. This gives a very strong coupling through the glass, resulting in very response to touch by the detecting wires.

Fig 12. shows an arrangement of conductive rectangles (7), on the surface of a sheet of glass. These rectangles are widely spaced apart and electrically isolated from each other.

Fig 13. shows the same arrangement as Fig12. but in side view. When the finger touches a conductive pad, it is sensed through the glass, by the bottom sensing layer. The conductive pads eliminate the possibility of detecting the exact point of touch, but give a strongly quantised signal when touched, making it very easy for the circuit to detect which pad has been touched and when.

Fig14. shows a pattern of conductive pads, on a sheet of glass, very close together, but separated by a very thin non-conductive zone. The close packing facilitates capacitive coupling sideways through the glass.

Fig15. shows a sideways view of the arrangement in Fig14. When the finger touches on of the conductive pads, it is detected through the glass by the conductive layer on the bottom. The small sideways capacitive coupling strengthens and spreads out the signal being detected.

Fig16. shows the same arrangement used in Fig 14, but with conductive pads on both the upper and lower surfaces of the glass, the two patterns being offset to produce an overlap of the two patterns. This overlap greatly increases the sideways capacitive coupling in the system, strengthening the signal detected by a touch.

Fig17. shows a sideways view of Fig16.. Strong capacitive coupling in the glass enables a strong signal to be detected by the bottom sensing layer.

Fig18. shows a pattern of conductive rectangles on the surface of a sheet of glass, but with thin, conductive bridges (8) joining them. This arrangement reduces the conductivity of the surface coat to a value that enables this invention to work in a similar way to that described in Fig7. When the finger touches a point on the surface, the touch signal is spread out radially across the surface, but diminishes in strength as the distance from that point increases. The rate of attenuation is to the resistance of the surface. The detection is similar to that produced by the system shown in Fig7. but the results are slightly quantised. Large pads produce strong quantisation, whereas very small pads produce much less quantisation.

Fig19. shows an arrangement, similar to that in Fig5, with the insulated sensing wires completely encapsulated by the conductive medium. The medium has, however, been formed, possibly injection moulded, into a curve or dome. Use of the conductive medium deforms the capacitance detection system and allows the finger to be detected at a point that would not be possible if a purely dielectric system, as described in the original patent, was used.

Fig20. shows a similar set-up to Fig19. but shows that the edges or corners of a moulding can still be used to detect the position of a finger, even though the sensing conductors are some distance away.

Fig 21. shows a similar set-up to Fig5. but with surface distortions. This shows that the conductive medium can be used to redirect the point of touch but still be accurately detected by the system.

Fig22. shows how a conductive film(4) , placed on top of the sensing medium (14) can be grounded, or earthed, through a wire link (13) or a resistor, thus enabling it to act as an anti-static, emi shielding membrane. The resistivity of the film is high enough to ensure that earthing does not interfere with the film's touch-enhancing properties.

Fig23. shows how a touch detection system (9) can be incorporated into the sensor's control system, enabling very rapid detection of touch. This touch detection may then use a circuit (10) to "wake-up" the controller (12) , thus enabling it to scan the system through the position detect circuitry (11) and, thereby, determine the exact position of touch.

#### Claims.

1. A method of altering the immediate environment of a capacitive, touch detection

- system to improve the accuracy and speed of touch detection of that system.
2. As in claim 1., by the provision of a slightly conductive medium encapsulating, or in close proximity to the insulated detection system.
  3. As in claim 1. but by the provision of a capacitively coupled medium in close proximity to the detection system.
  4. As in claim 1., but with a mixture of capacitive and resistive environment in close proximity to the detection system.
  5. Provision of a mixture of resistive environments to control the pattern of touch detection in a proximity detection system.
  6. Use of a conductive and/or capacitively coupled medium to physically distort the detection environment of a proximity detection system.
  7. Use of conductive plastic in an injection moulding, incorporating an array of capacitance detecting isolated conductors, to enable many or all parts of that moulding to be touch interactive, this including all surfaces, edges and corners.
  8. As in claim 7, where the moulding is the case of a piece of electronic equipment, such as a mobile phone, laptop computer etc..
  9. As in claim 2, where the conductive layer is connected to ground and doubles as a anti-static and emi shielding layer.
  10. As in claim 2, where the conductive layer is connected to a detection circuit and detects when its surface is touched.
  11. As in claim 10, where the touch detect signal is used to "wake-up" the position detecting circuit.

More claims to follow.

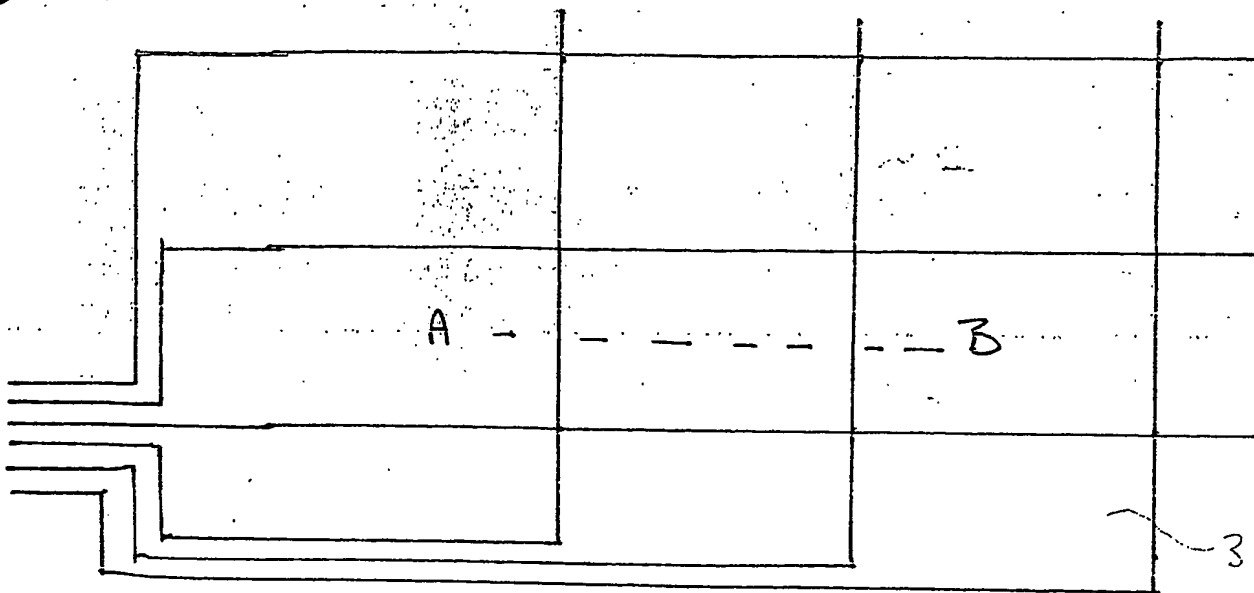


Fig 1

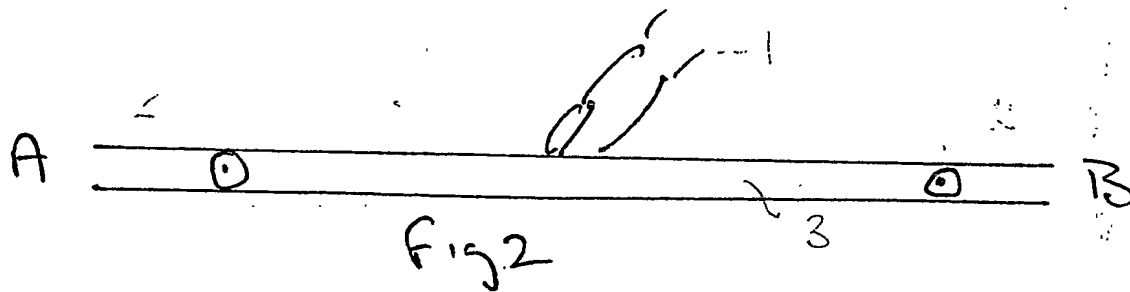


Fig 2

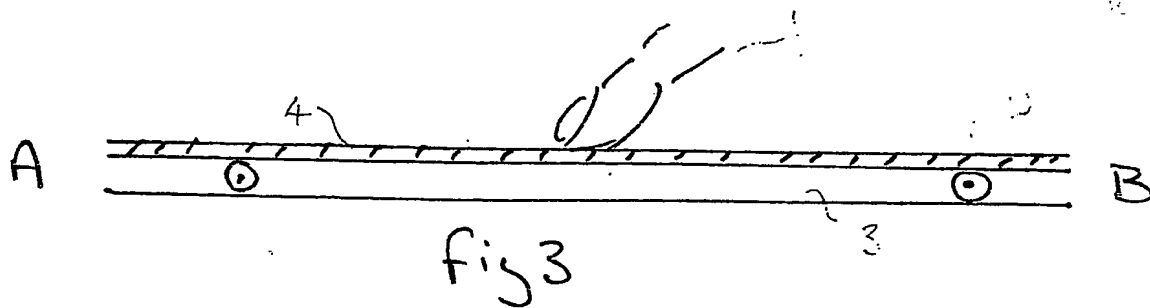


Fig 3

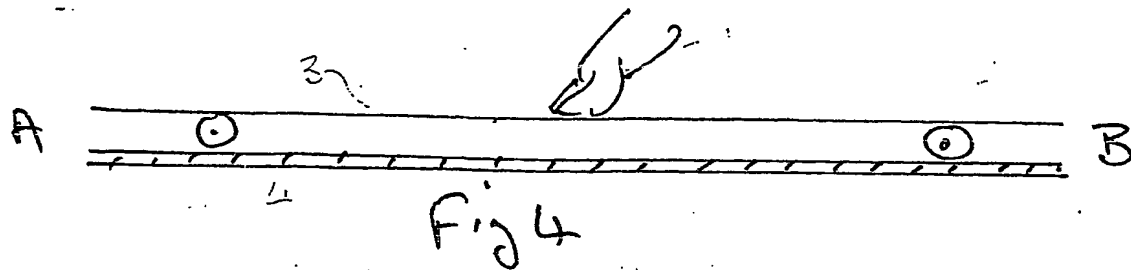


Fig 4

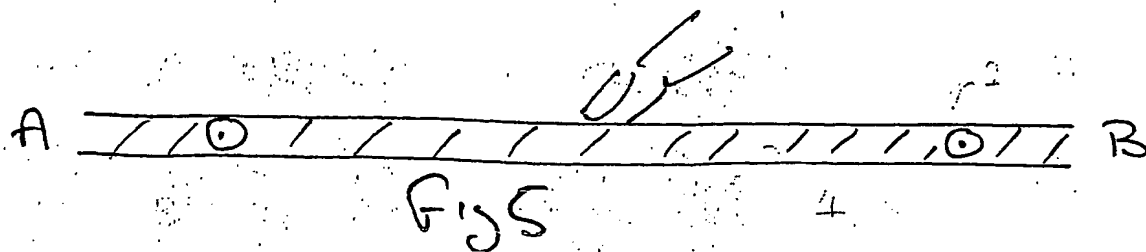


Fig 5

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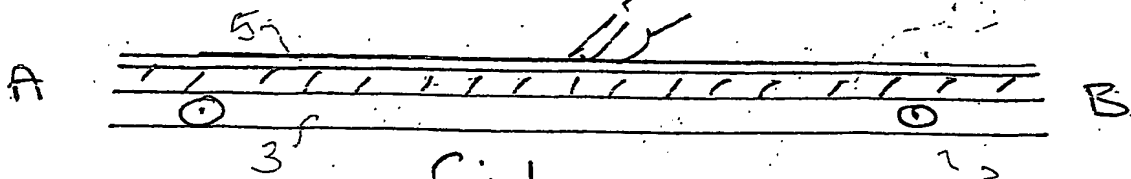


Fig 6

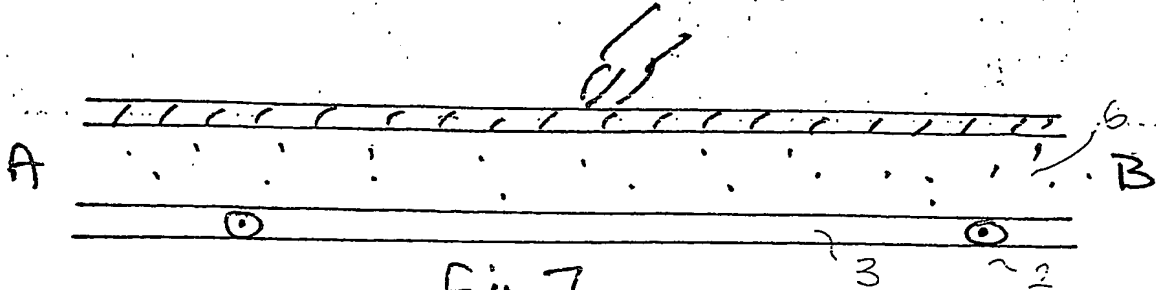


Fig 7

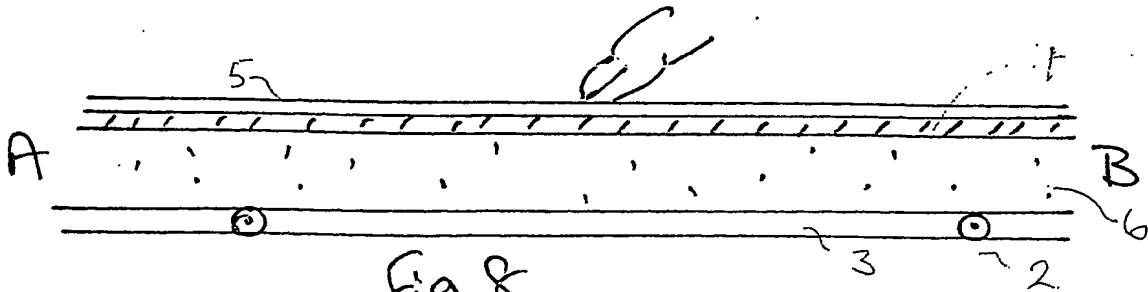


Fig 8

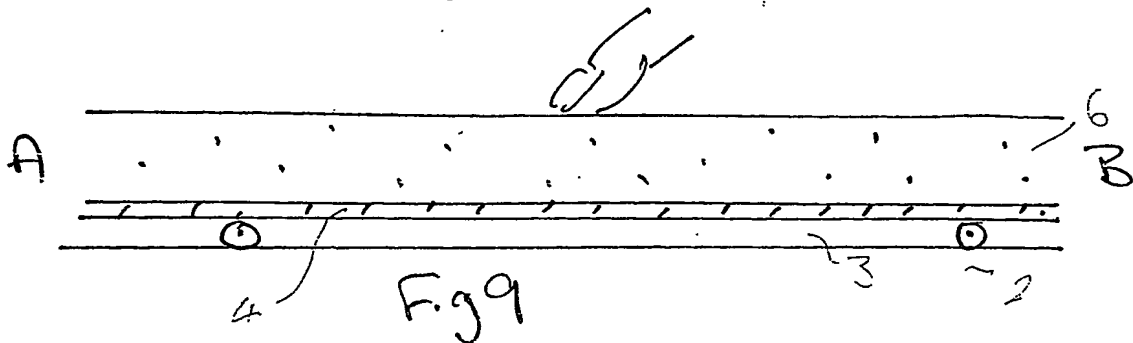


Fig 9

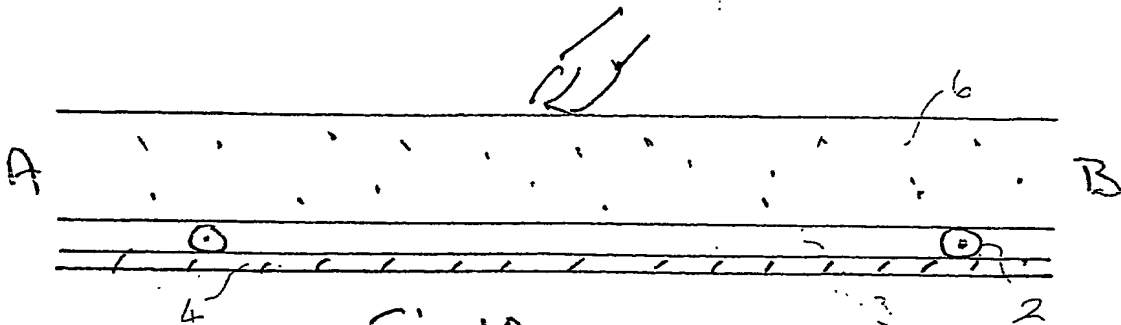
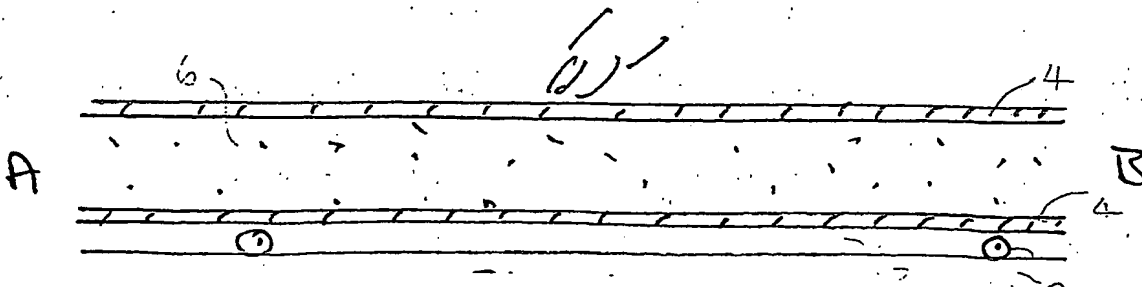
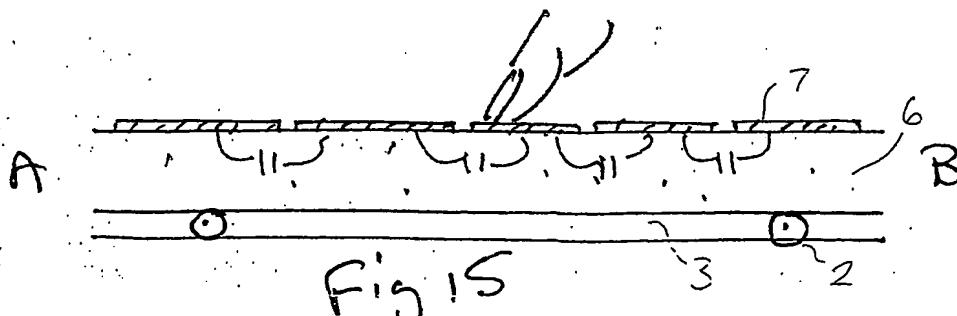
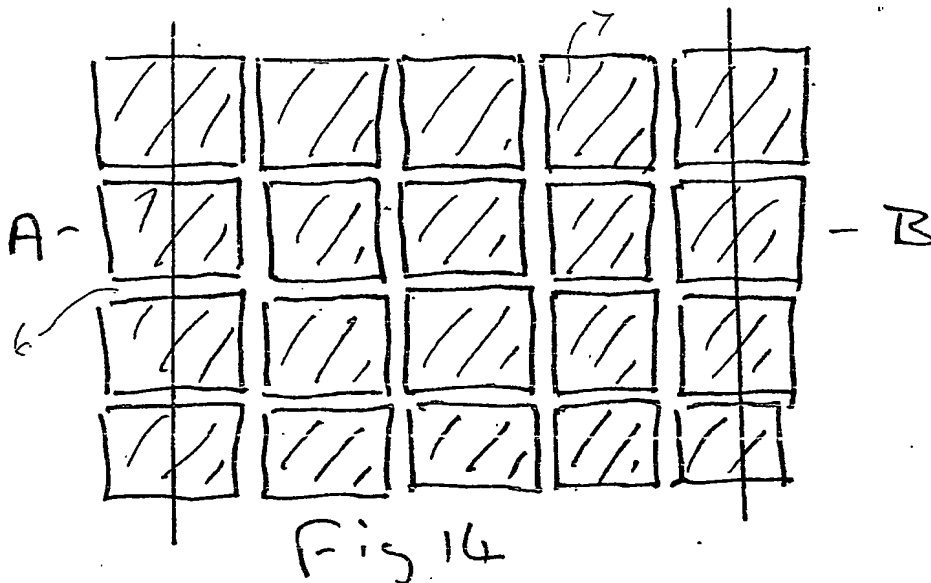
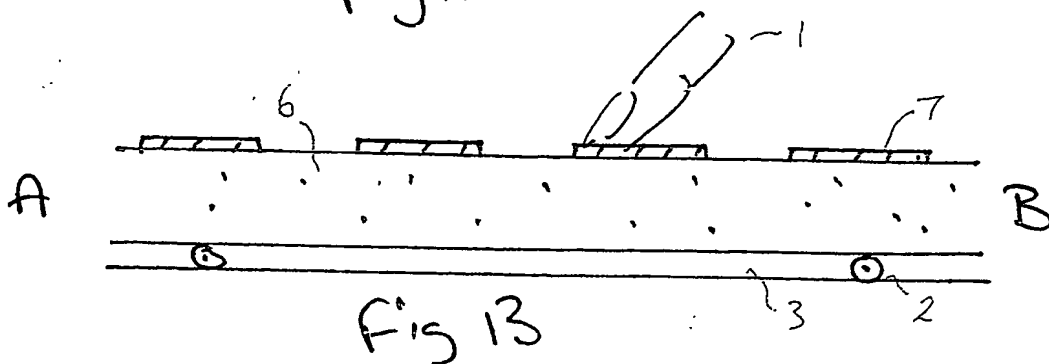
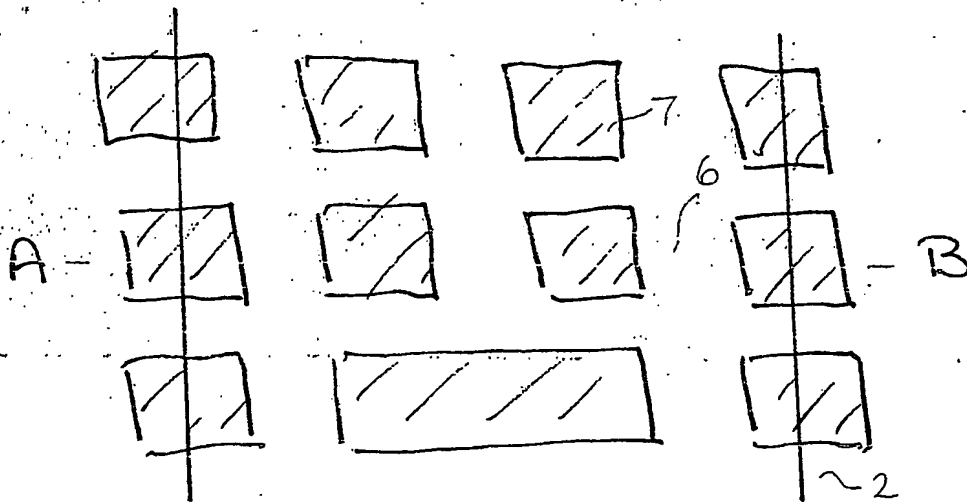


Fig 10





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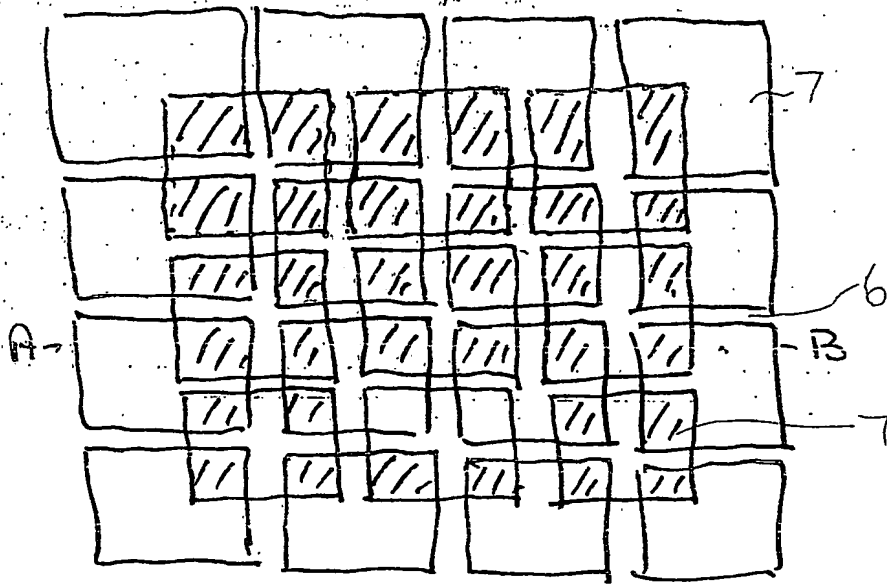


Fig 16

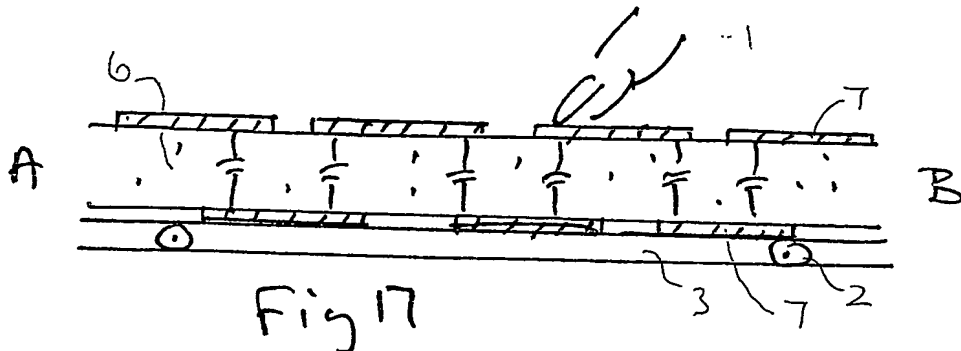


Fig 17

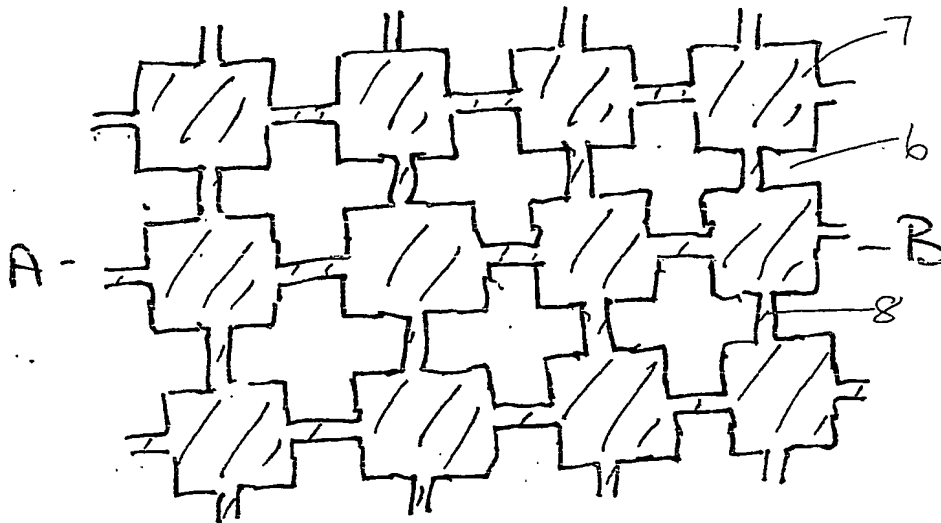
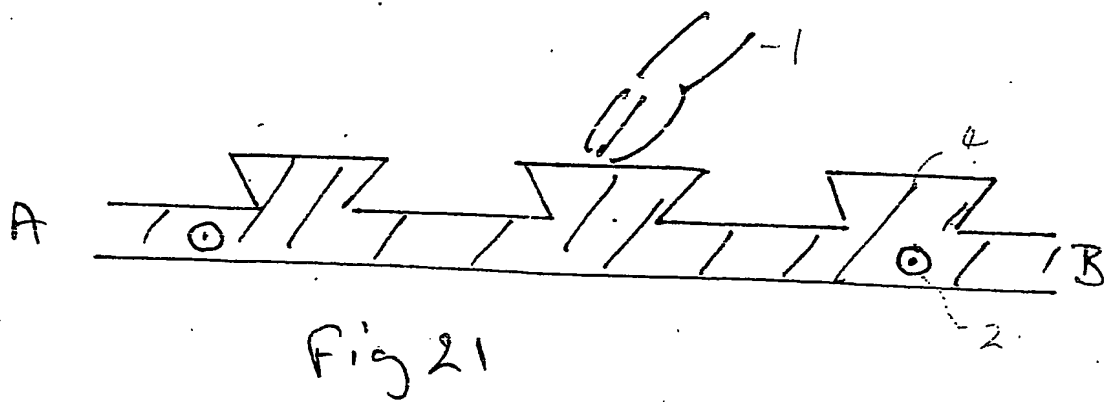
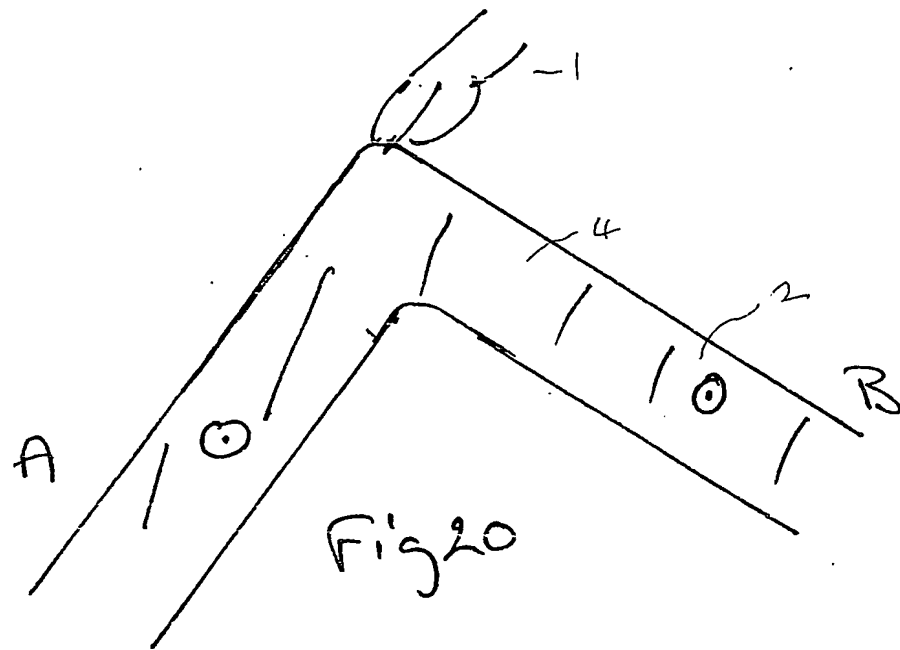
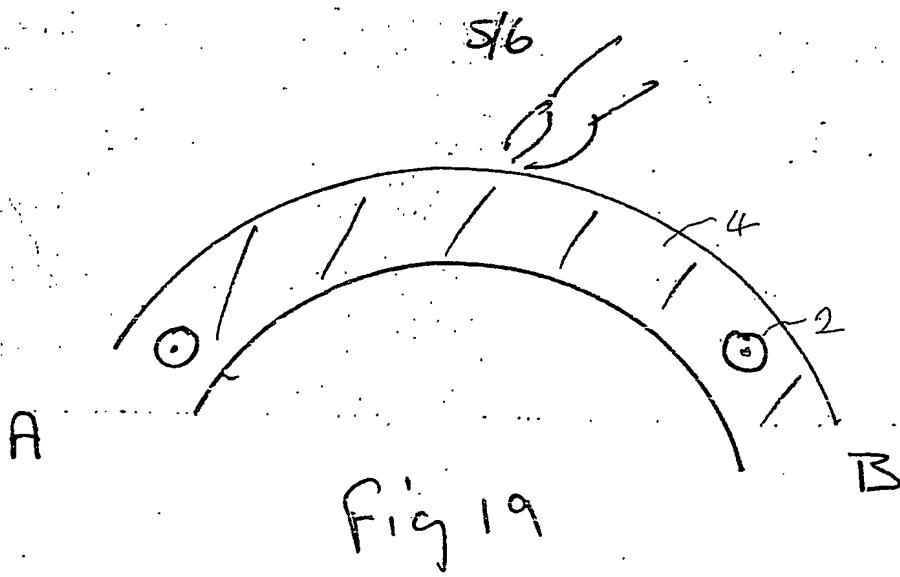


Fig 18





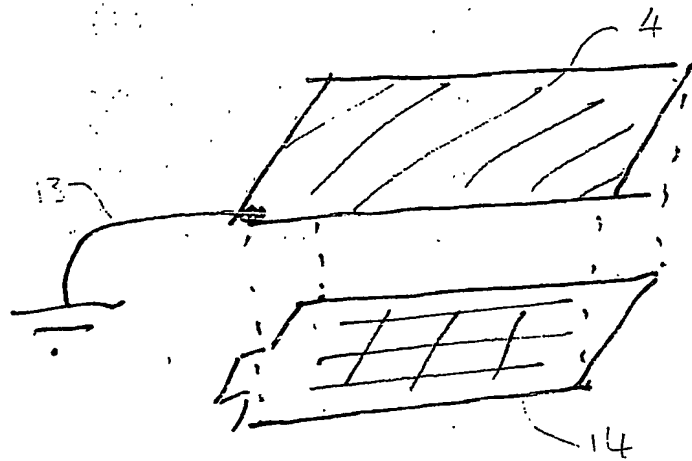


Fig 22

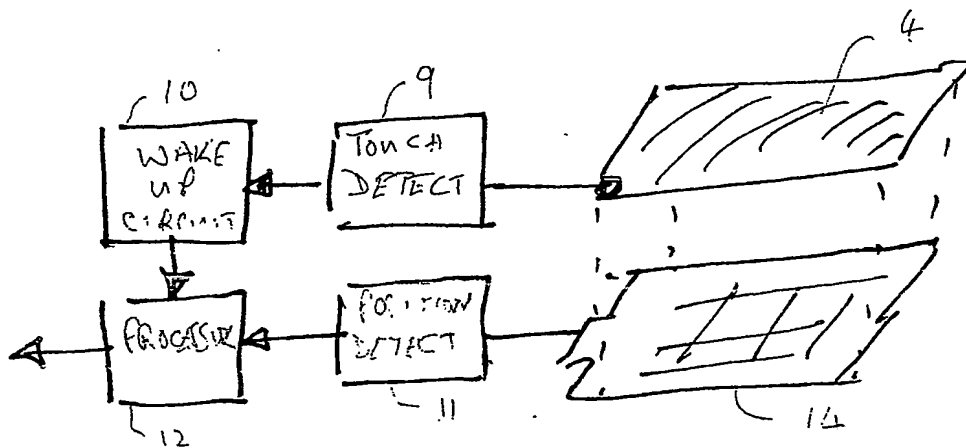


Fig 23

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